



### California Energy Commission

What is Biogas?

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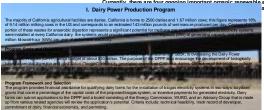
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Project Locations and Sizes
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Applications received are very representative of the distribution of dairies in California. The figure on the right shows the geographic databutions of California dairies and steed of the 14 approved projects. The awarded projects over dairy sizes from 175 – 7200 milking cows.

Types of Digester System
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Gallo Callis Company	Freestall	5001	Cov'd lagoon	38	\$4298	\$1,289,520
Stakes Landing Dairy	Freestall	237	Cov'd lagoon	75	\$1,811	\$105,800
Cartelanelli Bros. Dairy	Freestall	160	Cov'd lagoon	140	\$4821	\$772,925
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Van Ommoring Daily	Freestall	600	Plug flow	130	\$2764	569,314
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California P of ylochric State University Dairy	Freestall	125	Cov'd lagoon	30	\$2500	\$75,000
Plane View Daly	Drylot	1100	Wked	10	\$5,820	\$92,00
Lourence Dairy	Drylot	1258	Cov'd lagoon	152	\$1530	\$209,557
Inland Empire Utilities Agency	Valous	4700	Plug flow	50	\$2747	\$1,546,250
Eden-Valle Daly	Free-stallidylst	730	Plug flow	152	\$4412	\$61,93



Plot Testing
There are three utrasound suppliers that PER has looked into to provide for the technology. Waves, INE Tec, and Sonico. Each vendor has their own approach to the application of their utrasound systems and parameters. Testing of the different utrasound applications at the same site would entalle direct comparison and verification of the points all advantages of each systems. Ten extraction of the points all advantages of each systems. Cerea for the case and extraction of the points and ventor of the comparison and verification of the points all advantages of the chipself. The comparison are considered as the comparison and the comparison are considered as the comparison and the comparison are considered as the comparison and the comparison are considered as the considered as the comparison are considered as the consider





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- The location of the anaerobic digester on the Valley Fig Growers Plant is indicated by the figure on the right and estimated production is described by the table below.



The Ingers oil Rand (IR) microturbine is the selected technology for the electricity generation. The IR microturb will utilize the plant produces biogas as a renewable fuel and generate 45 – 70 kW of electricity. It has ultra-low emissions, and uses waste



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The project digester and microturbine technology have been chosen and the final design already completed. Construction is currently or going since April 2004. The digester is expected to be operational in January 2005.







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IWE Tec Equipment
The IWE Tec approach to ultrasound application for municipal sludges is based on partial treatment of the secondary sludge at seam. The ultrasound system consists of individual rod-shaped Cascader Cascader Within an individual cyl indical reactor.



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contaminants, such as hydrogen sulfide (H, S), slood generation.  The gas cleaning pilot system consists of testing ted drying, biological H, S removal system, and a packet	anes, and moisture (water vaper) from blogas will in the ologies that have potential to remove moisture, s e-existen for siloxene treatment, will be lested at a gram because a has microsublines and blogas gre- gian because a has microsublines and blogas gre-	reference the recommendation of the recommen
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- Anaerobic Digester Design Parameters

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  4,0000 gpd

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  5,000 gpd

  1,000 gpd

  1,000



Estimated Full Po	tential for Dige	zer	_
	Wastewater	Solids	Total
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Methane Production at 70% (thiday)	13,412	7,560	20,972
Total Daily Electricity Production (kWhiday)	1,062	598	1,660
Average Hourly Electrical Production (kW)	9	25	70

biogas as a renewable fuel and generate 45 - 70 kW of









# Biogas

# Renewable Energy Projects Under Public Interest Energy Research Program

**California Energy Commission** 





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Benefits of the Program
<ul> <li>Producing electricity from livestock wastes currently considered a waste disposal problem is the primary benefit of the program.</li> <li>Renewable electricity from biogas will help to offset expensive and valuable peak electricity.</li> </ul>
<ul> <li>Manure management and environmental benefits included reduced odor problems and methane emission. Digesters also provide benefits by reducing potential surface and groundwater contamination.</li> </ul>
<ul> <li>Cast savings to daries since the estimated electricity generation can offset most electricity usage on the dairy. Possible exeruse streams, such as the ability to self excess generated power back to utility company and utilization of biogas for healing or cooling purposes, can also increase the offset costs.</li> </ul>
Future Directions
DPPP will focus on expanding applications across California, based on the results and further evaluations of approved projects. The program

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### **PIER Goals**



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Lourence Dairy	Drylot	128	Cov'd lagoon	193	\$1,530	\$20,57
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Eden-Valle Daly	Free-staffdrylat	770	Plug flow	193	\$4412	\$61,93
Ridat Dairy II	Freestall	7200	2-stage plug flow	1000	\$4565	\$4,545,000



Pikel Testing

There are three ultrasound supplies that PER has looked into biprovide for the technology, Waves, IWE Tee, and Sonico. Each vendor has their own approach to the application of their ultrasound systems and parameters. Testing of the different ultrasound applications at the same site would enable direct companion and ventration of the posterial advantagate developed. Despite the provided as posterial per and Sonico, are selected for pilot setting at the City of Newseak Wester and Sonico, are selected for pilot setting at the City of Newseak Wester and Sonico, are selected for pilot setting at the City of Newseak Wester and Sonico, are selected for pilot setting at the City of Newseak Wester and Sonico, are selected for pilot setting at the City of Newseak Wester and Sonico, are selected for pilot setting and s



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Project Status and Expected Outcomes
This project is currently in as social aggregation for data collection and monitoring phases (present, baseline, ultracound, and configuration of baseline). The ultracount
This project is currently in as social aggregation from data projection, but display increased solid destruction, increased gas production, and improvements in
Configuration of the project of the projec



Project Status
Following the designing phase of the three gas cleaning systems, installation of the gas cleaning systems began in July 2004. Data collection and monitoring are out string place. First analysis and evaluation of the projects will be completed in 2005.

Overall, the biogasielectricity production generation from STPs is expected to increase by 50% with an incremental pay back period 2-3 years. By applying the advanced schrindogies that are being developed under the Commonwealth's program, the comprehensive results on capturing the energy and byproducts savings and environmental benefits will be achieved in Craffornia.



- naerobic Digester Design Parameters

   Hested, mix trapecid pond

   1,800,000 galdens

   40,000 galdens

   40,000 galdens

   40,000 galdens

   50,000 galden



Estimated Full Potential for Digester					
	Wastewater	Solids	Total		
Biogas Production (fi <sup>*</sup> iday)	19,160	10,800	29,960		
Methane Production at 70% (triday)	13,412	7,560	20,972		
Total Daily Electricity Production (Whiday)	1,062	598	1,660		
A wrage Hourly Electrical Production (kW)	45	25	70		





### I. Dairy Power Production Program

The majority of California agricultural facilities are dairies. California is home to 2500 dairies and 1.67 million cows; this figure represents 18% of 9.14 million milking cows in the US and corresponds to an estimated 143 million pounds of wet manure produced per day. Capture of a portion of these wastes for anaerobic digestion represents a significant potential for methane gas production. If biogas to electricity systems were installed at every California dairy, the systems would provide approximately 143 megawatt (MW) of generating capacity and over 1,000 million kilowatt-hour (kWh) per year of deliverable electricity.

### **Program Goals and Objectives**

Currently the California Energy Commission, acting under authority of Legislative enactment of SB5X, is over seeing the Dairy Power Production Program (DPPP) with a budge of about \$10 million. The purpose of the DPPP is to encourage the development of biologically based anaer obic digestion and gasification ("biogas") electricity generation projects on California dairies. Objectives of the program include developing commercially proven biogas electricity systems that can help California dairies offset the purchase of electricity, and providing environmental benefits by reducing air and ground water pollutants associated with storage and treatment of livestock wastes.

### **Program Framework and Selection**

The program provides financial assistance for qualifying dairy farms for the installation of biogas electricity systems in two ways: buydown grants that cover a percentage of the capital costs of the proposed biogas system, or incentive payments for generated electricity. Dairy farms can submit applications to the DPPP and a board consisting of the Energy Commission, WURD, and an Advisory Group that is made up from various related agencies will review the application's potential. Criteria include: technical feasibility, track record of developer, commitment of dairy, financial economics, and permitting.





### California Energy Commission

Blogas is a mixture of methane (CH<sub>6</sub>), carbon dioxide (CO<sub>2</sub>), and depending on the feedstock used, trace gases such as nitrogen, ammonia (NH<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), hydrogen sulfide (H<sub>2</sub>S), and hydrogen. Blogas is produced when certain bacteria decompose bi ological matter in an anaerobic (no oxygen is present) environment. This process is referred to as anaerobic digestion (AD).

AD is a proven technology for effectively treating the organic fraction of waster. The treatment of waster brough is a many benefits; it leads not only to a cleaner and healthier environment, but also produces a renewable energy source, methane. Methane is a combustible gas. The energy content of digester gas depends on the amount of methane it contains. Methane content varies from about 55 percent to 70 percent. Typical digester gas, with a methane concentration of 60 percent, contains about 600 Btu of energy per cubic foot.

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Enhancing energy recovery from biogas can be derived from four different feedstocks: landfill waste, livestock - dairy waste, food processing waste, and municipal sludge waste. However, this poster will only present the potential energy generation from t

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Project Locations and Sizes.

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digesters, mixed digesters, and 2-stage digesters. Most approved projects use the plug flow reactors and covered lagoons.

Program Status
Over 55 applications representing a funding over \$15 million have been
screened. A load of \$5.6 million have been awarded to 14 projects.
Fine projects are completed and producing bioglas and electricity.
Two projects will be completed by Mey 2005.
The 14 dainy farms have an estimated total electricity generation capacity of 3.5
MM from the biograp droution.
Details of each approved project size, manure management and type of
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Operations.

Doby Name	Dairy Type	Ladding Cows	Type of System	Ext MIII Capacity	Unit Cost SWW	Total Cost
Hamany Farms	Freestall	100	Cov'd lagoon	120	\$3017	\$30,00
Hilaridos Dairy	Drylot	6000 hillion	Cov'd lagoon	250	\$4,000	\$1,500,000
Gallo Catlis Company	Freestall	5001	Cov'd lagoon	38	\$4298	\$1,289,520
Blakes Landing Daily	Freestall	237	Cov'd lagoon	75	\$1,811	\$105,800
Castelanelli Brus. Dairy	Freestall	160	Cov'd lagoon	16	\$4821	\$772,925
Kostoler Daily	Drylot	1920	Plug flow	240	\$1,469	\$301,850
Van Ommoring Daily	Freestal	600	Plug flow	130	\$2764	569,314
Meadosbrook Daily	Freestall	1900	Plug flow	16	\$3,281	\$24,93
California P drytochric State University Dairy	Freestall	1%	Cov'd lagoon	30	\$2500	\$75,000
Plane View Daly	Drylot	1100	Wked	10	\$5,820	\$92,00
Lourence Dairy	Drylot	1258	Cov'd lagoon	193	\$1,530	\$209,557
Island Empire Utilities Agency	Valous	4700	Plug flow	5.0	\$2747	\$1,546,250
Eden-Valle Daly	Free stallidrylat	730	Plug flow	193	\$4412	\$61,93



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Project Status and Expected Outcomes
This project is currently in its second agreed of our data collection and monitoring phases (pretext, baseline, ultrascound, and configuration of baseline). The ultrascound this project is currently in its second agreed from data projection, including increased solids destruction, increased gas production, and improvements in deposition, increased pass production, and improvements in deaderstability. A constrained were serials of Soft-improvement in agreed production in production in production in production in the cost-effective analysis, paybads period for both systems is about two years.





Overall, the biogasielectricity production generation from STPs is expected to increase by 50% with an incremental pay back period 2-3 years. By applying the advanced schrindogies that are being developed under the Commonwealth's program, the comprehensive results on capturing the energy and byproducts savings and environmental benefits will be achieved in Craffornia.



- naerobic Digester Design Parameters

   Hested, mix trapecid pond

   1,800,000 galdens

   40,000 galdens

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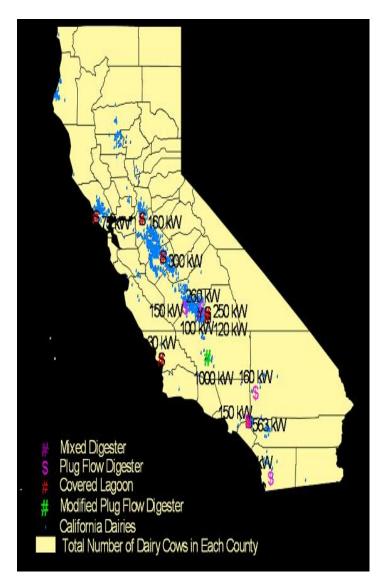
   50,000 galden

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		Estimated Full Potential for Digester							
Wastewater	Solids	Total							
19,160	10,800	29,960							
13,412	7,560	20,972							
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### **Project Locations and Sizes**

DPPP aimed to select projects that span geographically throughout California. Applications received are very representative of the distribution of dairies in California. The figure on the right shows the geographic distributions of California dairies and sites of the 14 approved projects. The awarded projects cover dairy sizes from 175 – 7200 milking cows.

### **Types of Digester System**

Types of proposed biogas system included covered lagoons, plug flow digesters, mixed digesters, and 2-stage digesters. Most approved projects use the plug flow reactors and covered lagoons.

### **Program Status**

Over 55 applications representing a funding over \$15 million have been screened. A total of \$5.8 million have been awarded to 14 projects.

- •Five projects are completed and producing biogas and electricity.
- •Seven projects will be completed by December 2004.
- •Two projects will be completed by May 2005.

The 14 dairy farms have an estimated total electricity generation capacity of 3.5 MW from the biogas production. Details of each approved project size, manure management and type of digester, cost, and estimated electricity capacity from biogas are included in the table below.





### California Energy Commission

Blogas is a mixture of methane (CH<sub>6</sub>), carbon dioxide (CO<sub>2</sub>), and depending on the feedstock used, trace gases such as nitrogen, ammonia (NH<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), hydrogen sulfide (H<sub>2</sub>S), and hydrogen. Blogas is produced when certain bacteria decompose bi ological matter in an anaerobic (no oxygen is present) environment. This process is referred to as anaerobic digestion (AD).

AD is a proven technology for effectively treating the organic fraction of waster. The treatment of waster brough is a many benefits; it leads not only to a cleaner and healthier environment, but also produces a renewable energy source, methane. Methane is a combustible gas. The energy content of digester gas depends on the amount of methane it contains. Methane content varies from about 55 percent to 70 percent. Typical digester gas, with a methane concentration of 60 percent, contains about 600 Btu of energy per cubic foot.

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Types of proposed biogas system included covered lagoons, plug flow
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The 14 daily farms have an estimated batal electricity generation capacity of 3.5 Mills with the December 2004 of 3.5 Mills with the December 2004.

The 15 daily farms have an estimated better by a project and type of digitater, coult, and estimated electricity capacity from biogsis are included in the resks. hardow.

Dulry Name	Dairy Type	Ladaling Coss	Type of System	Ext MIII Capacity	Unit Cost SWW	Total Cost
Hamony Farms	Free stall	100.0	Cov'd lagoon	120	\$3017	\$362,000
Hilaridos Dairy	English	6000 Notions	Cov'd lagoon	250	\$4,000	\$1,500,000
Gallo Callis Company	Freestall	5001	Cov'd lagoon	38	\$4298	\$1,289,520
Blakes Landing Daily	Free stall	237	Cov'd lagoon	75	\$1,811	\$105,800
Castelanelli Brus. Dairy	Freestall	1400	Cov'd lagoon	16	\$4821	\$772,925
Kontrior Daily	English	1920	Plug flow	240	\$1,469	\$301,850
Van Ommoring Dairy	Freestall	600	Plug flow	130	\$2764	569,314
Meadosbrook Dairy	Free stall	1900	Plug flow	16	\$3,281	\$24,93
California Polytechnic State University Dairy	Free stall	125	Cov'd lagoon	30	\$2500	\$75,000
Plane View Daily	English	1100	Wked	10	\$5,820	\$92,00
Lourenzo Dairy	English	1258	Cov'd lagoon	193	\$1530	\$209,557
Island Empire Ullifox Agency	Valous	4700	Plug flow	540	\$2747	\$1,546,350
Eden-Valle Dally	Free-stallidrylat	770	Plug flow	192	\$4412	\$61,93
Bidst Dairy B	Freestall	7200	2 stage plug flow	1000	\$4545	\$4545,000



Pikel Testing
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### IWE Tec Equipment The IWE Tec approach to ultrasound application for municipal sludges is based on partial treatment of the secondary sludge stream. The ultrasound system consists of individual red-athaged cascade" proves, each within an individual cylindrical reactor.

Project Status and Expected Outcomes
This project is currently in as social aggregation for data collection and monitoring phases (present, baseline, ultracound, and configuration of baseline). The ultracount
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- naerobic Digester Design Parameters

   Hested, mix trapecid pond

   1,800,000 galdens

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   40,000 galdens

   40,000 galdens

   50,000 galden



Estimated Full Potential for Digester						
	Wastewater	Solids	Total			
Biogas Production (fi <sup>*</sup> iday)	19,160	10,800	29,960			
Methane Production at 70% (triday)	13,412	7,560	20,972			
Total Daily Electricity Production (Whiday)	1,062	598	1,660			
A wrage Hourly Electrical Production (kW)	45	25	70			







### **Awarded Projects under DPPP**

Dairy Name	Dairy Type	Lactating Cows	Type of System	Est kW Capacity	Unit Cost \$/kW	Total Cost
Harmony Farms	Freestall	1050	Cov'd lagoon	120	\$3,017	\$362,000
Hilarides Dairy	Drylot	6000 heifers	Cov'd lagoon	250	\$6,000	\$1,500,000
Gallo Cattle Company	Freestall	5081	Cov'd lagoon	300	\$4,298	\$1,289,520
Blakes Landing Dairy	Freestall	237	Cov'd lagoon	75	\$1,811	\$135,800
Castelanelli Bros. Dairy	Freestall	1600	Cov'd lagoon	160	\$4,831	\$772,925
Koetsier Dairy	Drylot	1500	Plug flow	260	\$1,469	\$381,850
Van Ommering Dairy	Freestall	600	Plug flow	130	\$3,764	\$489,284
Meadowbrook Dairy	Freestall	1900	Plug flow	160	\$3,281	\$524,898
California Polytechnic State University Dairy	Freestall	175	Cov'd lagoon	30	\$2,500	\$75,000
Plane View Dairy	Drylot	1100	Mixed	100	\$5,820	\$582,000
Lourenco Dairy	Drylot	1258	Cov'd lagoon	150	\$1,530	\$229,557
Inland Empire Utilities Agency	Various	4700	Plug flow	563	\$2,747	\$1,546,350
Eden-Vale Dairy	Freestall/drylot	770	Plug flow	150	\$4,413	\$661,923
Bidart Dairy II	Freestall	7200	2-stage plug flow	1000	\$4,565	\$4,565,000





### California Energy Commission

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Colry Name	Dairy Type	Ladaling Cows	Type of System	Capacity	Unit Cost SW	Total Cost
Hamany Farms	Freestall	100.0	Cov'd lagoon	120	\$3017	\$342,000
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Gallo Catlis Company	Freestall	5001	Cov'd lagoon	38	\$4298	\$1,289,520
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California P of ylochric State. Unlearnity Dairy	Freestall	125	Cov'd lagoon	30	\$2500	\$75,000
Place View Daly	English	100	Wked	10	\$5,820	\$92,00
Lourence Dairy	Drylot	128	Cov'd lagoon	193	\$1,530	\$20,57
Intend Empire William Agency	Valous	4700	Plug flow	5.0	\$2747	\$1,546,350
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PRIO Textisp

There are three diffusion of suppliers that PICR has looked into to provide for the technology. Waves, IME Tec., and Sonico. Each vendor has their own approach to the application of their ultrasound optimism and parameters. Testing of the different ultrasound applications at the same site would enable direct comparison and ventilization of the policitation and the provision of the provision diversity and each yealers. Description, to explain, the IME Tec and Sonico, are selected for policitation; at the Quit of Venezia and all VIAS to Objecter #1, whereas, the IME Tec system will provide a partial treatment (30% TWAS flow) to Digester #2 and the remaining TWAS flow will bypass the ultrasound applications.

### IWE Tec Equipment The IWE Tec approach to ultrasound application for municipal sludges is based on partial treatment of the secondary sludge stream. The ultrasound system consists of individual red-athaged cascade" proves, each within an individual cylindrical reactor.



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	Wastewater	Solids	Total
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Methane Production at 70% (thiday)	12,412	7,560	20,972
Total Daily Electricity Production (kWhiday)	1,062	598	1,660





### **Benefits of the Program**

- •Producing electricity from livestock wastes currently considered a waste disposal problem is the primary benefit of the program. Renewable electricity from biogas will help to offset expensive and valuable peak electricity.
- Manure management and environmental benefits included reduced odor problems and methane emission. Digesters also provide benefits by reducing potential surface and groundwater contamination.
- •Cost savings to dairies since the estimated electricity generation can offset most electricity usage on the dairy. Possible revenue streams, such as the ability to sell excess generated power back to utility company and utilization of biogas for heating or cooling purposes, can also increase the offset costs.

### **Future Directions**

DPPP will focus on expanding applications across California, based on the results and further evaluations of approved projects. The program aims at centralizing digester facilities.





### **California Energy Commission**

Blogas is a mixture of methane (CH<sub>6</sub>), carbon dioxide (CO<sub>2</sub>), and depending on the feedstock used, trace gases such as nitrogen, ammonia (NH<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), hydrogen sulfide (H<sub>2</sub>S), and hydrogen. Blogas is produced when certain bacteria decompose bi ological matter in an anaerobic (no oxygen is present) environment. This process is referred to as anaerobic digestion (AD).

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HEarldon Dairy	Drylot	6000 Notions	Cov'd lagoon	250	\$4,000	\$1,500,000
Gallo Catle Company	Freestall	5001	Cov'd lagoon	38	\$4298	\$1,289,520
Blakes Landing Dairy	Freestall	237	Cov'd lagoon	75	\$1,811	\$105,000
Cadelanelli Brus. Dairy	Freestall	1400	Cov'd lagoon	140	\$4821	\$772,925
Kontrior Daily	Drylot	1920	Plug flow	240	\$1,469	\$391,850
Van Ommering Dairy	Freestall	600	Plug flow	120	\$2764	569,314
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Project Status
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Overall, the biogasielectricity production generation from STPs is expected to increase by 50% with an incremental pay back period 2-3 years. By applying the advanced schrindogies that are being developed under the Commonwealth's program, the comprehensive results on capturing the energy and byproducts savings and environmental benefits will be achieved in Craffornia.



- naerobic Digester Design Parameters

   Hested, mix trapecid pond

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   40,000 galdens

   40,000 galdens

   40,000 galdens

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### II. Commonwealth Renewable Energy Program

There are 311 Sewage Treatment Plants (STPs) in California with design average annual flows of 1 million gallons per day (mgd) or more. These STPs are advantages to renewable energy production because they can serve as one source of renewable energy. The anaerobic digestion process that is used at STPs produces combustible digester gas that can be compressed to generate energy.

### Program Purposes and Objectives

The overall purpose of this Commonwealth Renewable Energy Program is to make renewable energy part of an affordable and diverse electricity system in California, with energy production at STPs as one source of renewable energy. There are two key objectives in this project. The first one is to improve energy cost/value of California electricity by the development of piloting of thermal hydrolysis and ultrasound treatment systems to increase biogas production. The second aims at improving the environment, public health, and safety by developing and testing gas cleaning system well suited for microturbines.

### Optimization of Gas Production

The total estimated electricity production potential at STPs in California using conventional anaerobic digestion is about 230 MW. Enhanced digestion technologies could increase gas production by 20 to 50%. An average of 30% increase in biogas production corresponds to a potential of 300 MW of electricity. Thus the development of enhanced digestion technologies to increase total gas production will make the potential of renewable energy in California more attractive. Most of these technologies focus on the hydrolysis step, the breakdown of cells, which is generally the rate-limiting step that reduces the efficiency of digester gas production.

Two technologies that can be applied to improve the hydrolysis of organic solids produced at municipal wastewater treatment plants are:

- •Thermal hydrolysis, which uses high temperature and pressure to cause hydrolysis and break open cellular materials.
- •Ultrasound, which uses cavitation effect (the formation, growth, and rapid collapse of cells through the implosion of micro-bubbles in a liquid) of sound waves to disintegrate biosolids.

Ultrasound is currently favored because thermal hydrolysis technology has a higher cost and complexity. Availability in the U.S. market, simple installation, and operation of the ultrasound technology make it an attractive cost-effective method for optimizing gas production at municipal plants. Ultrasound systems are easy to retrofit on the secondary sludge feed line to the digester and have a small footprint. The energy demand of ultrasound system is small, and the net energy balance of the digestion process is improved to greater extent than with thermal hydrolysis.





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### **Pilot Testing**

There are three ultrasound suppliers that PIER has looked into to provide for the technology: Waves, IWE Tec, and Sonico. Each vendor has their own approach to the application of their ultrasound systems and parameters. Testing of the different ultrasound applications at the same site would enable direct comparison and verification of the potential advantages of each system. Currently, two systems, the IWE Tec and Sonico, are selected for pilot testing at the City of Riverside Water Quality Control Plant. The two systems are installed side-by-side and on the thickened waste activated sludge (TWAS) feed to digesters. The Sonico system will treat all TWAS to Digester #1, whereas, the IWE Tec system will provide a a partial treatment (30% TWAS flow) to Digester #2 and the remaining TWAS flow will bypass the ultrasound system.

### **Sonico Equipment**

The Sonico ultrasound system consists of individual 'radial' horns that are shaped like a ring donut. The horns are mounted in series in a reactor that contains three to five rings.



### **IWE Tec Equipment**

The IWE Tec approach to ultrasound application for municipal sludges is based on partial treatment of the secondary sludge stream. The ultrasound system consists of individual rod-shaped 'cascade" proves, each within an individual cylindrical reactor.



### **Project Status and Expected Outcomes**

This project is currently in its second stages of four data collection and monitoring phases (pretest, baseline, ultrasound, and continuation of baseline). The ultrasound technology is expected to provide measurable improvements in digestion, including increased solids destruction, increased gas production, and improvements in dewaterability. A conservative estimate of 30% improvement in gas production is predicted and electricity generation will be increased by an approximation of 125 kW. In the cost-effective analysis, payback period for both systems is about two years.





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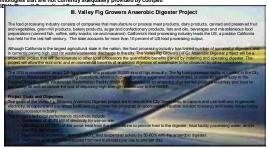








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The Ingersoll Rand (IR) microturbine is the selecter technology for the electricity generation. The IR microturb will utilize the plant produce biogas as a renewable fuel and generate 45 – 70 kW of electricity. It has ultra-low emissions, and uses waste





### **Optimization Microturbines Efficiency**

Besides the optimization of anaerobic digestion, improvement of the biogas treatment can also enhance energy recovery. Technologies that can remove harmful contaminants, such as hydrogen sulfide (H<sub>2</sub>S), siloxanes, and moisture (water vapor) from biogas will increase the conversion rate between biogas and electricity generation.

The gas cleaning pilot system consists of testing technologies that have potential to remove moisture, siloxanes, and H<sub>2</sub>S. These technologies, which include a gas drying, biological H<sub>2</sub>S removal system, and a package system for siloxane treatment, will be tested at the IEUA Regional Plant 1 (RP-1). The RP-1 facility has been selected to conduct the biogas cleaning pilot test program because it has microturbines and biogas generated using both municipal waste and manure. The demonstration trial will investigate the economic, practical and technical benefits of microturbines gas treatment technologies.





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Colty Name	Dairy Type	Ladaling Coss	Type of System	Ext MIII Capacity	Unit Cost SWW	Total Cost
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HEarlides Dairy	Drylot	6000 Notions	Cov'd lagoon	250	\$4,000	\$1,500,000
Gallo Catlle Company	Free stall	5001	Cov'd lagoon	38	\$4298	\$1,289,520
Blakes Landing Daily	Free stall	237	Cov'd lagoon	75	\$1,811	\$105,800
Cadelanelli Brox. Dairy	Freestall	1400	Cov'd lagoon	16	\$4821	\$772,925
Kontrior Daily	Drylot	1920	Plug flow	260	\$1,669	\$301,850
Van Ommoring Dairy	Freestall	600	Plug flow	130	\$2764	569,314
Meadonbrook Dairy	Freestall	160	Plug flow	16	\$3,281	\$24,81
California P of ylochric State. University Dairy	Free stall	125	Cov'd lagoon	30	\$2500	\$75,000
Plane View Daily	Drylot	1100	Wked	10	\$5,820	\$92,00
Lourence Dairy	Drylot	128	Cov'd lagoon	193	\$1,530	\$209,557
Island Empire Utilities Agenty	Valous	4700	Plug flow	5.0	\$2747	\$1,546,250
Eden-Valle Dally	Freestallidylst	770	Plug flow	193	\$4412	\$61,93
Ridari Dalay B	Freestall	7200	2-stage plug flow	1000	\$4565	\$4,545,000



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### IWE Tec Equipment The IWE Tec approach to ultrasound application for municipal sludges is based on partial treatment of the secondary sludge stream. The ultrasound system consists of individual red-athaged cascade" proves, each within an individual cylindrical reactor.

Project Status and Expected Outcomes
This project is currently in as social aggregation for data collection and monitoring phases (present, baseline, ultracound, and configuration of baseline). The ultracount
This project is currently in as social aggregation from data projection, but display increased solid destruction, increased gas production, and improvements in
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# III. Valley Fig Growers Anaerobic Digester Project he food processing industry consists of companies that manufacture or process meat products, dairy products, canned and preserved fru nd vegetables, grain mill products, bakery products, sugar and confectionery products, fast and ols, beverages and micellaneous food preparations (canned fish, coffee, safty snacks, ice and micrastron). California's food processing industry leads the U.S. a position California

- naerobic Digester Design Parameters

   Hested, mix trapecid pond

   1,800,000 galdrons

   40,000 galdrons

   40,000 galdrons

   40,000 galdrons

   50,000 galdrons

  -



	Wastewater Solids To							
	WA EDWADE	3000	1003					
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Total Daily Electricity Production (Whiday)	1,062	598	1,660					

The Ingers oil Rand (IR) microturbine is the selected technology for the electricity generation. The IR microturb generation. The increase will utilize the plant produced







### Gas Drying

A refrigerated dryer is selected as the technology for moisture removal. The system is skid mounted, suitable to handle biogas and consists of a refrigeration unit, a vertical heat exchanger and a control. The refrigerated dryer is sized to treat 50 standard cubic feet per minute (scfm) of biogas, which is equivalent to run four of the existing 30-kW microturbines (12 scfm per microturbines). The system will be installed downstream of the existing gas compressors and will be physically located east of the existing gas compressors and iron sponges.

### Biological H<sub>2</sub>S removal

The H<sub>2</sub>S found in biogas can be removed through a biological process by bacteria, in which the bacteria oxidized the sulfide to produce both elementary sulfur and sulfur acid. The system for the pilot test is sized to treat up to 100 scfm at 1,500 ppm H<sub>2</sub>S with turn down to 50 scfm at 500 ppm H<sub>2</sub>S content. The biological H<sub>2</sub>S removal system will be installed north of the digester No. 4 and this technology will be compared to the existing chemical H<sub>2</sub>S system using ferric chloride.

### Siloxane treatment system

Two siloxane packaged systems are proposed. One system, manufactured by Applied Filter Technology, consisted of customized units designed and built to match specific biogas cleaning requirements. These SAGPack series are a combination of compression, chilling, condensing/coalescing, siloxane removal, organic sulfur removal, desiccation, and particulate filters. The other company Pioneer Air Systems, Inc provides a gas drying unit with cyclic refrigeration that depends on liquid condensation and polishing with activated carbon. The packaged systems will be sized to treat 50 sfcm of biogas and located south-east of the digesters, close to the energy recovery building.





### California Energy Commission

What is Biogas?

Blogas is a mixture of methane (CH<sub>6</sub>), carbon dioxide (CO<sub>2</sub>), and depending on the feedstock used, trace gases such as nitrogen, ammonia (NH<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), hydrogen sulfide (H<sub>2</sub>S), and hydrogen. Blogas is produced when certain bacteria decompose bi ological matter in an anaerobic (no oxygen is present) environment. This process is referred to as anaerobic digestion (AD).

AD is a proven technology for effectively treating the organic fraction of waster. The treatment of waster brough is a many benefits; it leads not only to a cleaner and healthier environment, but also produces a renewable energy source, methane. Methane is a combustible gas. The energy content of digester gas depends on the amount of methane it contains. Methane content varies from about 55 percent to 70 percent. Typical digester gas, with a methane concentration of 60 percent, contains about 600 Btu of energy per cubic foot.

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The Ingers oil Rand (IR) microturbine is the selected technology for the electricity generation. The IR microturb will utilize the plant produces biogas as a renewable fuel and generate 45 – 70 kW of electricity. It has ultra-low emissions, and uses waste







### **Project Status**

Following the designing phase of the three gas cleaning systems, installation of the gas cleaning systems began in July 2004. Data collection and monitoring are currently taking place. Final analysis and evaluation of the projects will be completed in 2005.

### **Expected Removal Performance**

Based on available empirical data, existing biogas cleaning units can reduce  $H_2S$  concentration by 90-99%. This means that an  $H_2S$  concentration in the 2,000 ppm range before treatment can be reduced to lower than 20 ppm after treatment. Bench scale testing for siloxane removal using the refrigeration and condensation, indicates a reduction of over 50% of siloxane concentration.

### **Benefits**

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I. Dairy Power Production Program



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Estimated Full Potential for Digester						
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Methane Production at 70% (triday)	13,412	7,560	20,972			
Total Daily Electricity Production (kWhiday)	1,062	598	1,660			
Average Hourly Electrical Production (kW)	45	25	70			





### III. Valley Fig Growers Anaerobic Digester Project

The food processing industry consists of companies that manufacture or process meat products, dairy products, canned and preserved fruit and vegetables, grain mill products, bakery products, sugar and confectionery products, fats and oils, beverages and miscellaneous food preparations (canned fish, coffee, salty snacks, ice and macaroni). California's food processing industry leads the US, a position California has held for the last half-century. The state accounts for more than 10 percent of US food processing output.

Although California is the largest agricultural state in the nation, the food processing industry has limited number of successful digesters and is currently paying high cost for waste/wastewater discharge to the city. The Valley Fig Growers (VFG) Anaerobic Digester project will be a showcase project that will demonstrate to other food processors the quantifiable benefits gained by installing and operating digester. The project will allow the economic and environmental benefits of anaerobic digestion of wastewater to be observed by other companies.

The VFG is consisted of about 125 fig growers, who produce 15,000 tons of figs annually. The fig food processor facility is located in the City of Fresno. Wastewater from processing operations, which is high in digestible sugar and carbohydrates, is currently sent directly to the Fresno/Clovis Regional Wastewater Reclamation Facility (RWRF). Installation of an anaerobic digester will produce electricity and heat for the facility, as well as reduce the cost of disposing high strength wastewater to the RWRF.

### **Project Goals and Objectives**

The goals of the Valley Fig Growers Anaerobic Digester project are to reduce the City Sewer fess, to capture and use methane to generate electricity, to capture and use waste heat, and to promote the project as an economically feasible solution to energy and waste issues facing the food processor industry.

The project's technical performance objectives include:

- •Generation of 45-70 kW of electricity for use on-site
- •Utilization of 50-100% of the waste heat from the microturbine to provide heat to the digester, heat facility processing water, and/or the VFG dehydrator.
- •Reduction of wastewater strength (BOD<sub>5</sub> and suspended solids) by 50-80% with the anaerobic digester.
- •Reduction of offsite solids disposal from two truckloads per day to one per day.





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Lourence Dairy	Drylot	128	Cov'd lagoon	193	\$1,530	\$209,557
Inland Empire Utilities Agency	Valous	4700	Plug flow	5.0	\$2747	\$1,546,250
Eden-Valle Daly	Free-staffdrylat	770	Plug flow	193	\$4412	\$61,93
Bidst Dairy B	Freestall	720	2-stage plug flow	1000	\$4565	\$4,545,000



Place Testing
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# III. Valley Fig Growers Anaerobic Digester Project he food processing industry consists of companies that manufacture or process meat products, dairy products, canned and preserved fru nd vegetables, grain mill products, bakery products, sugar and confectionery products, fast and ols, beverages and micellaneous food preparations (canned fish, coffee, safty snacks, ice and micrastron). California's food processing industry leads the U.S. a position California

- 10,000 gpd
- The location of the anaerobic digester on the Valley Fig Growers Plant is indicated by the figure on the right and estimated production is described by the table below.



	Wastewater	Solids	Total
Biogas Production (filid ay)	19,160	10,800	29,860
Methane Production at 70% (triday)	13,412	7,560	20,972
Total Daily Electricity Production (kWh/day)	1,062	598	1,660
Average Hourly Electrical Production (KW)	4	25	70

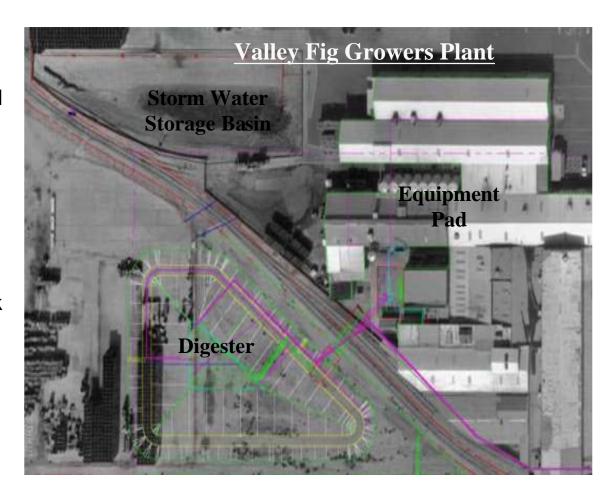




# **Anaerobic Digester Design Parameters**

- •Heated, mix trapezoid pond
- •1,800,000 gallons
- •40,000 gpd
- •45 day hydraulic retention time (HRT)
- •Double liner with leachate collection system
- •XR-5 reinforced geomembrane bank-to-bank cover for gas collection

The location of the anaerobic digester on the Valley Fig Growers Plant is indicated by the figure on the right and estimated production is described by the table below.







### California Energy Commission

Blogas is a mixture of methane (CH<sub>6</sub>), carbon dioxide (CO<sub>2</sub>), and depending on the feedstock used, trace gases such as nitrogen, ammonia (NH<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), hydrogen sulfide (H<sub>2</sub>S), and hydrogen. Blogas is produced when certain bacteria decompose bi ological matter in an anaerobic (no oxygen is present) environment. This process is referred to as anaerobic digestion (AD).

AD is a proven technology for effectively treating the organic fraction of waster. The treatment of waster brough is a many benefits; it leads not only to a cleaner and healthier environment, but also produces a renewable energy source, methane. Methane is a combustible gas. The energy content of digester gas depends on the amount of methane it contains. Methane content varies from about 55 percent to 70 percent. Typical digester gas, with a methane concentration of 60 percent, contains about 600 Btu of energy per cubic foot.

### Biogas as a Renewable Energy

Enhancing energy recovery from biogas can be derived from four different feedstocks: landfill waste, livestock - dairy waste, food processing waste, and municipal sludge waste. However, this poster will only present the potential energy generation from t

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Early technical potential assessment review shows that the potential energy generation from biogas to be promising in California. The estimated total energy is about 348 MW, where 138 MW is from municipal studge waste, 210 MW from animal waste biogas, and the potential biogas energy from food wastes is still needed to be determined. The overall objective that PIER aims to achieve is to increase biogas production that will result in higher energy recovery, which in return will make electricity more afforda

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Types of Digester System
Types of proposed biogas system included covered lagoons, plug flow
digesters, mixed digesters, and 2-stage diges ters. Most approved projects use
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- Program Status

  Over 55 applications representing a funding over \$15 million have been
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Duky Name	Dairy Type	Ladaling Gres	Type of System	Ext MM Capacity	Unit Cost SWE	Total Cost
Hamony Farms	Freestall	100	Cov'd lagoon	130	\$3017	\$362,000
Hillarides Dairy	Drylot	6000 Notions	Cov'd lagoon	250	\$4,000	\$1,500,000
Gallo Callis Company	Freestall	50(1	Cov'd lagoon	38	50298	\$1,289,520
Blakes Landing Dairy	Freestall	227	Cov'd lagoon	75	\$1,811	\$105,800
Castebnelli Bros. Dairy	Freestall	160	Cov'd lagoon	16	\$4821	\$772,925
Kortsier Dahy	Drylot	190	Plug flow	26	\$1,669	\$301,850
Van Ommoring Dairy	Freestall	600	Plug flow	120	\$2764	569,314
Mondonbrook Dairy	Free stall	1900	Plug flow	140	\$3,281	\$24,98
California P of ylochric State. University Dairy	Free stall	125	Cov'd lagoon	20	\$2500	\$75,000
Plane View Daly	Enylist	1100	Wked	10	\$5,820	\$92,00
Lourence Dairy	Enylist	1258	Cov'd lagoon	152	\$1530	\$209,557
Inland Empire Willies Agency	Valous	4700	Plug flow	50	\$2747	\$1,546,250
Edon-Valin Dalry	Free-dalidylst	730	Plug flow	152	\$4412	\$61,93
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- nærobic Digester Design Parameters

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   1,800,000 gald

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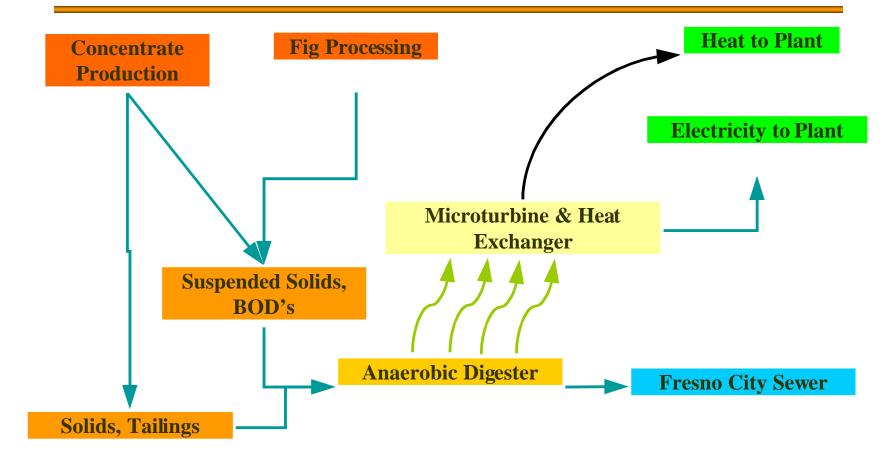




### **Estimated Full Potential for Digester**

	Wastewater	Solids	Total
Biogas Production (ft <sup>3</sup> /day)	19,160	10,800	29,960
Methane Production at 70% (ft <sup>3</sup> /day)	13,412	7,560	20,972
Total Daily Electricity Production (kWh/day)	1,062	598	1,660
Average Hourly Electrical Production (kW)	45	25	70

### PROCESS FLOW CHART



The Ingersoll Rand (IR) microturbine is the selected technology for the electricity generation. The IR microturbine will utilize the plant produced biogas as a renewable fuel and generate 45 – 70 kW of electricity. It has ultra-low emissions, and uses waste heat to increase overall efficiency.







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### **Project Status**

The project digester and microturbine technology have been chosen and the final design already completed. Construction is currently on going since April 2004. The digester is expected to be operational in January 2005.

### **Project Benefits**

The generation of electricity and heat while reducing sewer costs will lead to an estimated net benefit per year of \$141,000. This estimation is based on the expectation of 90% overall wastewater strength reduction which equates to \$112,000 in annual sewer bill savings, a \$16,000 of electricity generated annually, and \$13,000 of captured exhaust heat annually. Payback period is calculated to be 4.2 years. There is also the regional benefit of high potential for energy savings from reduced aerated treatment at Fresno Treatment Plant.